



Subspeciation in *Lachnagrostis adamsonii* (Poaceae)

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Introduction

The Victorian endemic grass, *Lachnagrostis adamsonii* (Vickery) S.W.L.Jacobs (syn. *Agrostis adamsonii* Vickery) was only known from a single 1853 collection, labelled 'Melbourne' and lodged at the Herbarium, Royal Botanic Gardens, Kew (K), until it was re-collected along with other wetland grasses in a small depression on a road verge near Glenthompson in 1987. This specimen was originally identified as *Lachnagrostis filiformis* (G.Forst) Trin., which it superficially resembles, but a positive determination as *L. adamsonii* was soon made when viewed under the microscope. The short, non-geniculate and near apically attached awn on the lemma, plus the glabrous nature of the lemma itself, were clear identifying features. At the time, searches through MEL failed to find any misidentified or indeterminate examples of the taxon.

Three years later, a further and larger population was found at Skipton (D. Frood 1990 pers comm), which initiated survey and monitoring programs as part of a recovery plan for the species under the auspices of the then Victorian Government Department of Natural Resources and Environment (currently part of the Department of Environment, Land, Water and Planning). In addition, various student projects (unpublished) into salt tolerance aspects of *L. adamsonii* were conducted at the University of Ballarat during the latter half of the 1990s. In recent

Abstract

Variation within *Lachnagrostis adamsonii* (Vickery) S.W.L.Jacobs is assessed and two new subspecies from the central region of the western Victorian Volcanic Plain are described: *L. adamsonii* subsp. *ampla* A.J.Br. from inundated, saline sites and *L. adamsonii* subsp. *limasa* A.J.Br. from slightly saline, moist lake beds and flats.

Key words: taxanomy, morphalogy, Adamsan's Blawn-grass

years, during research on control of *L. filiformis* on Lake Burrumbeet and Lake Learmonth in western Victoria, plants were found that did not conform to *L. filiformis* but appeared more similar to *L. adamsonii* (Warnock 2009).

Lachnagrostis adamsonii is listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and as 'Threatened' under the *Victorian Flora and Fauna Guarantee Act 1988* (Murphy 2010).

Previous studies of morphology and molecular markers (Random Amplified Polymorphic DNA-fragments (RAPDs) and Amplified Fragment Length Polymorphisms (AFLPs) found significant variation within *L. adamsonii* (James & Brown 2000; Brown 2013). In recognition of this variation, the current paper introduces new infraspecific taxa within *L. adamsonii* based on examination of a wide series of collections across known sites.

Materials and methods

Following the rediscovery of *Lachnagrostis adamsonii* in 1987, extensive field surveys were conducted during 1993–1997 throughout western Victoria. Survey work was extended into the Wimmera River catchment during 2002–2004, as part of research on salt-tolerant native grasses for the Cooperative Research Council (CRC) for Plant-based Management of Dryland Salinity. Additional searches into south-east South Australia have also been made.

Plant growth in the field (Brown unpub.) and under nursery conditions (James & Brown 2000; Brown 2013) has been examined and, although not reported here, does contribute to comments made concerning distribution, growth habit and habitat. All field and nursery collections have been examined morphologically, with the results summarised as descriptions in the taxonomic section below.

Results and discussion

Survey work has resulted in the species being collected from about 80 sites across south-western Victoria but not extending into South Australia. It remains surprising that a species could be relatively widespread across a well-inhabited region and remain undiscovered

for so long. One factor that may help to explain this phenomenon is that the grass has only ever been found on moist, saline soils and, as these are often of small extent, they are generally regarded by property owners and land managers as 'waste ground' and only supportive of 'weeds'. However, evidence for the ephemeral nature of the grass is also a factor in the species being overlooked. During the drought years of 2001–2009, all of the known populations were observed to be in decline (Murphy 2010) and many sites currently appear devoid of any plants of the species. In addition to the drying out of sites during the drought, the lack of water table movement resulted in the gradual decrease of surface soil salinity and allowed the invasion of exotic grasses, including *Holcus lanatus* L. and *Phalaris aquatica* L. An additional competitive stress has derived from the spread of the tall tussock grass, *Lophopyrum ponticum* (Podp.) A.Love into *Lachnagrostis adamsonii* habitat (Booth et al. 2009).

Morphological examination has revealed a number of traits not formerly recognised for the species, including hairs on the lemmas, spikelets to 4 mm long, lemma awns to 6 mm long and anthers to 1 mm long. Although these increased ranges in the nature and size of characters show no clear demarcation between populations at a broad geographic level, examination of varying combinations of morphological features in relation to habitat is suggestive of real genetic distinctions and differentiation through environmental adaptation. Therefore, two new subspecies are recognised and described below: *L. adamsonii* subsp. *ampla* A.J.Br. and *L. adamsonii* subsp. *limosa* A.J.Br.

There is support for recognition of infraspecific taxa within *L. adamsonii* from previous studies of molecular markers. Ordination of RAPD data (James & Brown 2000) and clustering of AFLP data (Brown 2013) across populations of *L. adamsonii* both yielded patterns that were largely consistent with the proposed taxonomic arrangement. For RAPDs, only subsp. *adamsonii* (five populations) and subsp. *ampla* (one population) were sampled, but there was clear separation of the five samples of the latter from the other 16 samples (which were more widely scattered in the ordination). For AFLPs, two samples (from the same population) of subsp. *ampla* and five samples (from three populations) of subsp. *limosa* each fell in separate clusters with high

Key to *Lachnagrostis adamsonii* subspecies

- 1 Lemma awn usually 3 mm long or less; spikelet usually 3.5 mm long or less; culm usually 1.5 mm wide or less; leaves usually 1 mm wide or less (plants of highly saline, short-term inundated sites) *L. adamsonii* subsp. *adamsonii*
- 1: Lemma awn usually greater than 3 mm long; spikelet usually 3.5 mm long or more; culm usually 1.5 mm wide or more; leaves usually 1 mm wide or more 2
- 2 Lemma awn less than 4.5 mm long, inserted at 60% of the lemma back or higher; anthers usually 0.7 mm long or more; leaves usually 1.5 mm wide or more; mature non-senesced inflorescence partly enclosed by leaf-sheath and semi-contracted (plants of saline, long-term inundated sites) *L. adamsonii* subsp. *ampla*
- 2: Lemma awn usually 4.5 mm long or more, inserted at less than 60% of the lemma back; anthers 0.7 mm long or less; leaves usually 1.5 mm wide or less; mature non-senesced inflorescence more or less exerted and spreading (plants of slightly saline sites) *L. adamsonii* subsp. *limosa*

statistical support, while the remaining five samples of subsp. *adamsonii* did not cluster together (albeit with low statistical support for some placements). Further analysis of a wider range of populations across an expanded set of molecular markers would be instructive, particularly in respect of variation within subsp. *adamsonii*. For the moment, the combination of morphological and molecular (RAPD, AFLP) data supports recognition of subspecies *ampla* and *limosa* as separate to the type subspecies.

Examination of individual plants within any one of almost all of the 80-odd known populations of *L. adamsonii* shows most to be of uniform morphology. Only in a handful of cases (Lake Goldsmith; Dashwood Station, Barunah; Corunnun, Lake Corangamite; Mt Weejort; and Mailmans Track, Skipton) is there some evidence of possible integration between the morphological types, described as subspecies below. Furthermore, nursery-grown plants have retained the characters of their populations, reinforcing the entrenched genetic differences between them. On the other hand, full species recognition in the face of some integration of characters is probably not justified.

Taxonomy

***Lachnagrostis adamsonii* (Vickery) S.W.L. Jacobs, *Teleopea* 9: 445 (2001)**

Agrostis adamsonii Vickery. *Contr. New South Wales Natl. Herb.* 1: 107 (1941).

Type: VICTORIA. 'Melbourne', F.M. Adamson 226, 12.xi.1853; holotype (K). [exact location unknown but, given its current distribution, is likely to have been a saline environment to the west of the City of Melbourne].

Caespitose or rarely shortly stoloniferous, glabrous, *annual* or *short-lived perennial*, to 90(–120) cm tall including inflorescences; culms erect to geniculate, 1–4 mm wide, usually unbranched, 4- or 5-noded; nodes glabrous, light brown and commonly hidden by leaf sheaths; internodes smooth or scabridulous; leaf sheaths often inflated at lower nodes and becoming loose from the culm above, striate, smooth or scabridulous between the nerves. *Leaf* blades dull green to bluish-green when fresh, shallowly grooved, involute (although basal leaves becoming flattened with senescence), smooth, sometimes scabridulous on exposed margins, up to 2 mm wide (unflattened), basal to mid culm leaf blades 10–50 cm long, upper culm leaf blades less than 10 cm long; ligules membranous, acute, becoming lacinate, (2–)4–6(–7) mm long. *Inflorescence* an open panicle, 15–25(–55) cm long and 15–25(–30) cm wide, becoming shortly exerted with maturity, peduncle and rachis retrorsely strigose to scabridulous, abscising at maturity; primary branches clustered (commonly 4–7 at lowest whorls), spreading, antrorsely scabridulous; secondary branching not occurring within at least the basal third of the length of lower branches; spikelets slightly overlapping towards the ultimate branch terminals. *Spikelets* 2.5–4 mm long, green to purplish-green; pedicel subclavate, scaberulous; rachilla extension present, 0.8–2.3 mm long including hairs; glumes not widely diverging, subequal or commonly the upper longer by up to 0.5 mm, scabrous on the keels, smooth on the lateral faces, entire to ciliate on the upper margins; lemma 2–3.3 mm long, 5-nerved, entire or 2–4-toothed, callus with a dense tuft of hairs 0.5–0.7 mm long, back and/or laterals glabrous or with sparsely scattered hairs confined to the mid-third region, awned;

awn arising from upper half of lemma length, 1.2–6 mm long, straight, slightly curved or gently sinuate but never strongly geniculate; palea subequal to the lemma or shorter by up to 0.6 mm, shortly bifid; stamens 3, dehiscent anthers (0.4–)0.5–1 mm long; caryopsis broadly ellipsoid giving the spikelet a distinct swollen appearance.

Common name: Adamson's Blown-grass.

Lachnagrostis adamsonii* subsp. *adamsonii

Annual or short-lived perennial; culms 1–1.5 mm wide, unbranched. *Leaf blades* usually 1 mm wide or less when unflattened. *Spikelets* 2.5–3.5(–3.7) mm long, green to purplish-green; rachilla extension 0.8–1.7(–2) mm long; lemma 2–2.5(–2.8) mm long, entire or toothed with minute setae to 0.2 mm long, back and laterals glabrous except for the callus, or with occasional to some hairs 0.3 mm long; awn arising from 65–95% of the lemma length from its base, 1.2–3(–3.3) mm long; dehiscent anthers (0.4–)0.5–0.7 mm long. Fig. 1a–e.

Notes: The observation of scattered hairs on the backs of the lemmas in about half the populations of *Lachnagrostis adamsonii* subsp. *adamsonii* is contrary to the original description of the taxon, where the lemmas were stated to be glabrous (Vickery 1941). Apart from this feature, morphological characteristics of inflorescences and spikelets between glabrous and hairy-lemma populations are not significantly different. Populations with hairs on the lemmas are more prevalent in the western part of the taxon's range while those with completely glabrous lemmas are most common in the east.

Only at Mailmans Track, Skipton, do some plants (approximately 20% of those measured) show spikelets slightly exceeding 3.5 mm length, lemmas slightly exceeding 2.5 mm length and awns slightly exceeding 3.0 mm, and, in these respects, they approach *L. adamsonii* subsp. *ampla*. However, these plants differ from subsp. *ampla* in having generally narrower culms and leaves, glabrous or near-glabrous lemmas and anthers 0.5–0.7 mm length. One collection at Mailmans Track (A.J. Brown 2225), growing in water in a roadside ditch, with spikelets to 4.3 mm length, hairy lemmas to 3.1 mm length, awns to 4.2 mm length, awn insertion of 65% of the lemma length and anthers of 1 mm length, conforms to subsp. *ampla*. The nearest known

population of subsp. *ampla* to Mailmans Track is 8.5 km to the west, on the corner of Millers Road and the Glenelg Highway.

Distribution: Endemic to western Victoria between Portarlington on the Bellarine Peninsula in the east and around Cavendish to the west of the Grampians.

Habitat: Largely confined to areas with average annual rainfall of 500–700 mm, where it is only found on moderately to severely saline, ephemeral swamps, depressions and drainage lines, in association with a range of highly salt-tolerant grasses and forbs. Does not tolerate prolonged inundation. Rarely found in association with *Lachnagrostis adamsonii* subsp. *limosa*.

Selected specimens examined: VICTORIA. 7 km ESE of Glenthompson on the Glenelg Highway, 17.xi.1987, A.J. Brown 332 (MEL); 6 km SW of Glenthompson on Van Renens Lane, 10.i.1994, A.J. Brown 829 (AD, NSW, CANB, MEL); 3 km S of Skipton, Mailmans Track, 11.i.1994, A.J. Brown 864 (MEL); Caramut on the Warnambool-Caramut Rd just S of town, 7.xii.1995, A.J. Brown 1013 (MEL); 3 km E of Beeac on the Mingawalla Rd, 7.xii.1995, A.J. Brown 1017 (MEL); 7 km W of Wickliffe on Williamson's Rd, 7.xii.1995, A.J. Brown 1023 (MEL); 5 km E of Willaura, Hopkins River flats on Delacombe Way, 21.xii.1995, A.J. Brown 1103 (MEL); 4 km W of Barunah on the Cressy-Shelford Rd, on the Mia Mia Ck, 21.xii.1995, A.J. Brown 1113 (MEL); 0.5 km E of Moorabool at Cowies Ck crossing of Warner's Rd, 4.i.1996, A.J. Brown 1144 (MEL); 4 km W of Mount Mercer on the Mount Mercer-Dereel Rd, 4.i.1996, A.J. Brown 1145 (MEL); 4 km N of Lismore, cnr of Linton and Graham Rds, 5.i.1996, A.J. Brown 1147 (MEL); 5 km N of Bushy Ck on Yarrock Rd, 5.i.1996, A.J. Brown 1151 (MEL); Lake Goldsmith off Skipton Rd, 6.xii.1996, A.J. Brown 1188 (MEL); 1 km E of Melville Forest on the Cavendish-Coleraine Rd, 31.xii.1996, A.J. Brown 1267 (MEL); 3 km N of Haddon on the Ross Ck-Haddon Rd, 10.xi.1997, A.J. Brown 1326 (MEL); 6 km N of Bulart, 12.xii.1997, A.J. Brown 1432 (MEL); Moyston-Great Western Rd, between Rhymney Reef and Rhymney, 11.xi.2003, A.J. Brown 2337 (CANB, MEL); 2 km S of Warrak on the Buangor-Ben Nevis Rd, 20.xi.2003, A.J. Brown 1776 (MEL); easement opposite Black Rock Rd, Breamlea, 23.ii.2004, A.J. Brown 1729 (MEL); 1 km from Geelong Rd on Point Richards Rd, Portarlington, 17.i.2008, A.J. Brown 1893 (MEL).

***Lachnagrostis adamsonii* subsp. *ampla* A.J.Br., subsp. nov.**

Differs from subsp. *adamsonii* in its more robust culms and general growth and in its usually longer glumes, lemmas, awns and anthers.



Figure 1. *Lachnagrostis adamsonii* subsp. *adamsonii*: **a.** inflorescence $\times 0.3$; **b.** floret (with lemma hairs) $\times 10$; **c.** floret (glabrous lemma) $\times 10$; **d.** anther $\times 10$; **e.** spikelets $\times 5$. *L. adamsonii* subsp. *ampla*: **f.** spikelet $\times 10$; **g.** anther $\times 10$; **h.** floret $\times 10$. *L. adamsonii* subsp. *limosa*: **i.** floret (with hairs) $\times 10$; **j.** floret (glabrous lemma) $\times 10$; **k.** inflorescence $\times 0.3$.

Type: VICTORIA. St. Marnocks Station, Eurambeen-Streatham Road, Crossroads; 4.i.1996, A.J. Brown 1129; holotype (MEL 2384083); isotypes (CANB, HO).

Short-lived perennial; culms 1.5–3 mm wide, occasionally branching at nodes in very mature plants. *Leaf blades* (1–)1.5–2 mm wide when unflattened. *Spikelets* (3.3–)3.5–4 mm long, greyish- to purplish-green; rachilla extension (1–)1.5–2.5 mm long; lemma 2.5–3.3 mm long, entire or toothed with minute setae to 0.3 mm long, back and/or lateral faces with few to some hairs 0.5 mm long; awn arising from 60–75% of the lemma length from its base, 3–4.4 mm long; dehiscent anthers (0.6–)0.7–1 mm long. Fig. 1f–h.

Notes: The inflorescences of subsp. *ampla* remain partly enclosed and contracted by the leaf sheaths until late maturity, when the lower leaf blades and sheaths have already senesced and much of the seed has fallen. Because of this, mid-season plants appear to have smaller inflorescences in relation to their culms. While mature specimens usually exceed 60 cm in overall height, it is not unusual for mid-season plants of subspecies. *adamsonii* and *limosa* to reach the same height, except they display a much higher proportion of inflorescence to leafy tussock, particularly as their panicles are more or less fully exerted and actively spreading at this time.

Some plants collected in saline waterholes in the Mt Weejiort area have slightly smaller spikelets than typical for the subspecies but do conform in respect to lemma awn and anther length and general growth habit (e.g. culm and leaf width, partly enclosed inflorescences).

Distribution: Confined to a few sites in the central region of the Volcanic Plain in western Victoria.

Habitat: Growing in saline swamps and drainage lines that remain inundated or waterlogged over the majority of the summer.

Etymology: After the Latin for 'large'.

Selected specimens examined: VICTORIA. 9 km W of Skipton, cnr of Millers Rd and Glenelg Highway, 1.xii.1989, A.J. Brown 454 (MEL) & 15.xii.1995, A.J. Brown 1057 (MEL); 5 km ESE of Mt Weejiort on Mt William Rd, 16.xi.1994, A.J. Brown 947, 948, 951 (MEL) & 6.xii.1996, A.J. Brown 1187 (MEL); St. Marnocks Station, Eurambeen-Streatham Road, Crossroads; 16.xi.1994, A.J. Brown 949, 950 (MEL); 5 km N of Derrinallum on the Vite Vite Rd, 15.xii.1995, A.J. Brown 1059 (MEL) & 13.i.2012, A.J. Brown 2554 (MEL); 3 km S of Skipton, Mailmans Track, 28.xii.2001, A.J. Brown 2225 (MEL).

***Lachnagrostis adamsonii* subsp. *limosa* A.J.Br., subsp. nov.**

Differs from subsp. *adamsonii* in its longer glumes, lemmas and awns and from subsp. *ampla* in its longer awns and usually smaller anthers.

Type: VICTORIA. Lake Burrumbeet, off Lake Burrumbeet Park, Cassidys Road, Burrumbeet; 28.xi.2008, A.J. Brown 2443; holotype (MEL 2384084); isotypes (AD, NSW, CANB, HO).

Annual or short-lived perennial; culms 1.5–3 mm wide, usually unbranched. *Leaf blades* usually 1–1.5 mm wide when unflattened. *Spikelets* 3.5–4(–4.5) mm long, green to purplish-green; rachilla extension 1.3–2(–2.5) mm long; lemma (2.7–)3–3.3 mm long, toothed with small setae to 0.7 mm long, back and/or lateral faces glabrous, except for the callus, or with occasional to few hairs; awn arising from 50–60% of the lemma length from its base, 4.5–6 mm long; dehiscent anthers 0.5–0.6(–0.7) mm long. Fig. 1i–k.

Notes: This subspecies grows in association with subsp. *adamsonii* along the Mia Mia Creek on Dashwood Station, Barunah. Here, it is less common than subsp. *adamsonii* and is mainly confined to the outer fringes of saline flats. The two subspecies also grow together on the flats of Lake Goldsmith where, again, subsp. *adamsonii* appears to grow in the more saline areas. The only other site where the two subspecies have been found is at Corunnun, on the eastern shore of Lake Corangamite, but collected in different seasons, and not seen in sympatry (subsp. *adamsonii* on 25.i.2001, subsp. *limosa* on 17.xi.2012).

Lachnagrostis adamsonii subsp. *limosa* had been overlooked until the last decade because its long awns were considered diagnostic of *L. filiformis* (G.Forst.) Trin. (Common Blown-grass). However the non-geniculate awns of *L. adamsonii* subsp. *limosa* and its usually larger lemmas serve to separate it from *L. filiformis*.

Distribution: Scattered across the central region of the Volcanic Plain of western Victoria.

Habitat: Found growing on drying lake beds, depressions and on the outer flats of salt lakes, where soils are only slightly saline. Probably less tolerant of waterlogging than subspecies *adamsonii* and *ampla*.

Etymology: After the Latin for 'muddy': the same meaning for the Aboriginal word 'burrumbidj' from which Lake Burrumbeet derives its name.

Selected specimens examined: VICTORIA. 3 km SE of Weering on the Barpinba-Winchelsea Rd, 5.i.1996, A.J. Brown 1153 (MEL), 4.ii.1997, A.J. Brown 1314 (MEL) & 11.xii.2001, A.J. Brown 186B (MEL); Lake Goldsmith off Skipton Rd, 6.xii.1996, A.J. Brown 1189, 1190 (MEL); Dashwood Station, Barunah, on the Mia Mia Ck, 19.xi.1997, A.J. Brown 1360, 1361 (MEL) & 15.i.1998, A.J. Brown 1490 (MEL); Lake Burrumbeet off Lake Burrumbeet Park, Cassidys Road, Burrumbeet, 6.xii.2007, A.J. Brown 2150, 2153 (MEL); Lake Learmonth off Foreshore Rd, Learmonth, 6.xii.2007, A.J. Brown 2157, 2158 (MEL); Lake Bookar, 29.xi.2008, A.J. Brown 2450, 2451 (MEL); Foxhow, Lake Corangamite, 11.ii.2011, A.J. Brown 2306 (MEL); Corunnun, Lake Corangamite, 17.xi.2012, A.J. Brown 2596 (MEL).

Note

A few populations of *Lachnagrostis* have been collected from outside the normal range of *L. adamsonii* and have been informally regarded as *L. aff. adamsonii*, e.g. specimens with long (> 4.5 mm) but non-geniculate lemma awns from the Craigieburn grasslands (8.xii.1989, D. Frood 036/89 (MEL); 1.i.1990, D. Frood 001/90 (MEL); 5.ii.1990, D. Frood 002/90 (MEL)); specimens with short (approx. 1.4 mm), non-geniculate lemma awns from the flats adjacent the Upper Yarra Reservoir (6.viii.2008, A.M. Bennett s.n. (MEL)). However, compared to *L. adamsonii*, these plants usually have flat leaves, 2–3.5 mm wide (rather than involute leaves, 0.5–2 mm wide in the unflattened state), usually higher spikelet to lemma length ratio (1.3–2.2 compared to 1.1–1.4) and smaller anthers (0.5 mm long or less compared to 0.5 mm long or more). In these features, these plants have greater affinity to *L. filiformis* than to *L. adamsonii*.

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